Table 4 – Results of gamma-ray spectrometry analysis of slag factions

Slag fractions (mm) to produce FeNi alloy	C_i, Bq/kg			$C_{sum.}$, Bq/kg	$C_{eff.}$, Bq/kg
	^{40}K	^{226}Ra	^{232}Th		
<2,5	112,0	63,0	36,3	211,0	120,0 ± 12,5
10-20	84,3	53,1	44,5	182,0	119,0 ± 13,1
>40	67,3	61,8	37,0	166,0	116,0 ± 13,5

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RESEARCH OF SORPTIVE FEATURES OF SLAG

Reuse of industrial waste in various industries, including construction materials wastes requires prior research of their chemical properties, surface structure and sorption activity.

The aim of the work was to determine the sorption capacity of metallurgical slag of Pobuzhsky Ferronickel Plant (PFNK) with respect to the organic dye methylene blue (MB).

PURPOSE: determination of the change of surface morphology under different conditions, to ascertain the conditions of slag activation with increasing of speed and sorption capacity.

Morphological features of slag surface were studied by means of scanning electron microscope JSM-6390 LV. Using of scanning electron microscopy showed the presence of the amorphous state of substances and the structure-porosity on the sample surface of PFNK slag. According to characteristics of the surface layer, slag is a good sorbent with numerous microscopic protrusions, recesses, and the presence of sorption active centers.

To increase the degree of loosening the surface, increasing the number of compounds in the amorphous state and increase of sorption capacity of slag is necessary to conduct its chemical activation. Microscopic examination of slag

surface, activated by various chemical agents, showed changes in the surface morphology of slag (etching and loosening) when treated by solutions of acids and alkali (Fig. 1).

Response of the slag surface with acid leads to the formation of amorphous gel as a result of polycondensation of the active silicic acid. There were registered amorphous formations with blurred boundaries in the structure of the bulk. Loosening of the surface is directly related to an increase in sorption capacity: the more developed the surface is, the greater sorption activity gets the slag sorbent.

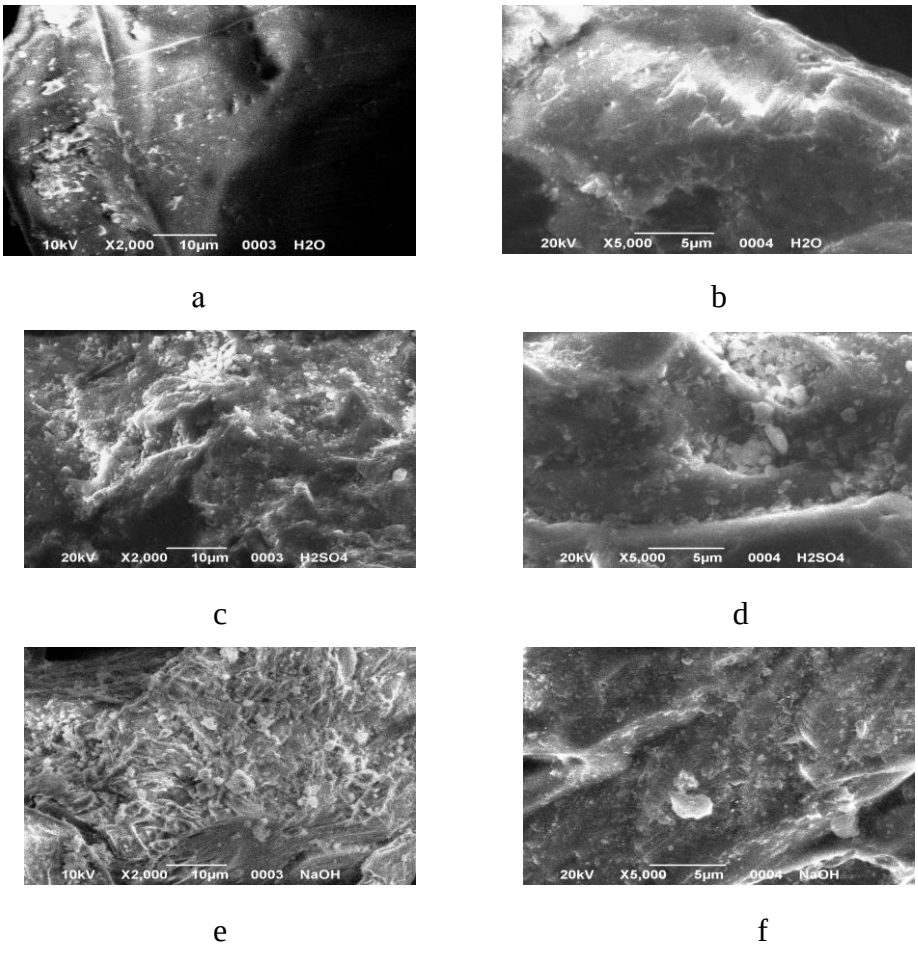

Figure 1 – Photomicrographs of PFNK slag surface when it is activated, a, b – by water, c, d – 0.5 M H_2SO_4; e, f – 1 M NaOH at magnifications: a, c, e – 2000; b, d, f – 5000

The sorption properties of slag were determined under static conditions according to changing of sorbate concentrations in MB solution. Sorption was studied by means of spectrophotometric method using SPEKOL 11 at wave length of λ = 620 nm. Static exchange capacity of the slag (SEC) was determined by the following formula

$$SEC = \frac{(C_1 - C_2) \cdot V}{m}, \text{mg / g},$$

where C_1 and C_2 – concentrations of sorbate, before and after sorption, mg/dm^3;

V – volume of solution, dm^3; m – mass of sorbent, g.

The slag was prepared to pre-sorption by exposure in water solutions of acids or alkalis NaOH at different temperatures during one day. Sorption was carried out under static conditions. The ratio of slag and MB solution (C = 0,01 g/dm^3) 5 g: 100 ml. Time of exposure time – 3 days. The experimental results are shown in table 1.

Activation of slag as sorbent MB in acid solutions is more effective compared to the alkaline treatment and soaking in water. The highest efficiency of MB solution extraction is achieved by pre-exposure in 0.5 M solution of H_2SO_4. The effectiveness of activated slag varies with temperature. When activated by water SEC and the efficiency of MB extraction from the liquid phase do not change considerably. For alkali solution minimum of SEC is observed within the temperature range – 40-50 °C, the maximum value of SEC – at 70-80 ^{o}C. When activated in sulfuric acid solution, the minimum SEC of slag according to MB is observed in the temperature range 50-60 °C. Raising of temperature to 70-80 °C resulted in a slight increase in SEC. The highest value of SEC is observed at 20 °C (Fig. 2). Thus, the most desirable is the chemical activation of sulfuric acid at 20^{o}C.

However, when activated by different agents the change of the surface may be due to dissolution of various chemical components of slag. The calculation of the oxide composition of slag based on the results of the micro roentgen analysis revealed change in the chemical composition in different types of chemical activation. Any type of chemical exposure leads to leaching of aluminum, silicon and magnesium from slag. Compared with aqueous acid and alkali treatment reduce the activation of magnesium and iron.

Table 1 – Change of sorption capacity of PFNK slag in acid and alkaline activation

Pre-soaking in solution	t, ^{o}C	Mass concentration of MB after sorption, g/dm^3	Extraction efficiency of MB from solution, %	SEC of slag, mg/g
1 M HCl	20	0,0028	72	0,144
1 M HNO_3	20	0,0028	72	0,144
0,5 M H_2SO_4	20	0,0023	**77**	**0,154**
0,25 M H_2SO_4	20	0,0031	69	0,138
0,125 M H_2SO_4	20	0,0032	68	0,136
0,05 M H_2SO_4	20	0,0033	67	0,134
0,025 M H_2SO_4	20	0,0038	62	0,124
0,005 M H_2SO_4	20	0,0039	61	0,122
0,5 M H_2SO_4	40	0,0049	51	0,102
0,5 M H_2SO_4	50	0,0061	39	0,078
0,5 M H_2SO_4	60	0,006	40	0,08
0,5 M H_2SO_4	70-80	0,0056	44	0,088
1 M NaOH	20	0,0039	61	0,122
1 M NaOH	40	0,0056	44	0,088
1 M NaOH	50	0,0054	47	0,092
1 M NaOH	60	0,0052	48	0,096
1 M NaOH	70-80	0,003	70	0,14
H_2O	20	0,0046	54	0,108
H_2O	40	0,0044	56	0,112
H_2O	50	0,0051	49	0,098
H_2O	60	0,0059	41	0,082
H_2O	70-80	0,0054	46	0,092

In addition, sulfuric acid activation of slag leads to dissolution of compounds of potassium and manganese. Alkaline activation causes dissolution of silica. The total loss of parts by weight of the order of these elements: 5,78 % in the acidic environment and 11,52% – in alkaline. The maximum value of SEC slag after acid activation under static conditions was set for 20 days (Fig. 3).

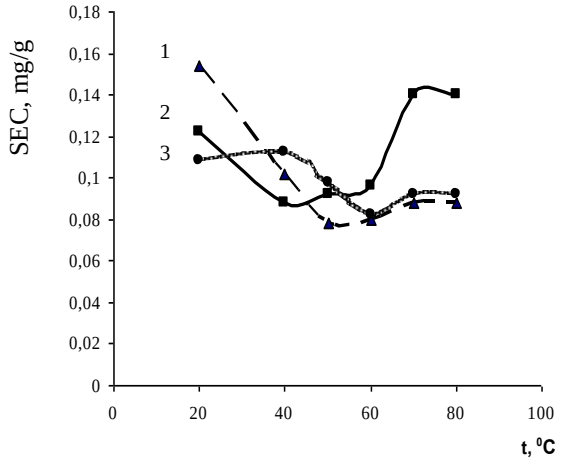

Figure 2 – Changing of slag SEC when it is activated: 1 – in solution of 0,5 M H_2SO_4; 2 – in solution of 1 M NaOH; 3 – in water at different temperatures

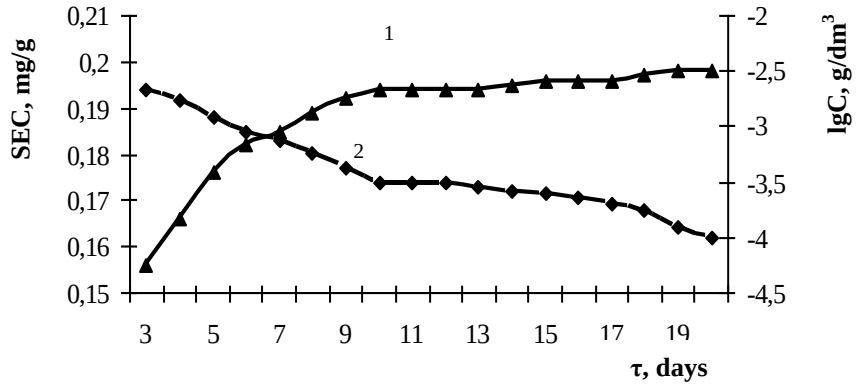

Figure 3 – Changing of SEC of PFNK slag and concentration of MB sorbate in solution during the time period of: 1 – SEC, mg/g, 2 – lgC (g/dm^3)

Thus, the expression of sorption properties of metallurgical slag in relation to organic dyes is shown. It was determined that an increase in sorption capacity of slag is due to the increase in the fraction of the amorphous state of substances and increase of surface area of slag at its acid activation.

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КОМПЛЕКСУВАННЯ РАДАРА ТА ВІДЕОКАМЕРИ ПРИ АВТОНОМНІЙ НАВІГАЦІЇ РОБОТІВ НА НЕЗНАЙОМІЙ МІСЦЕВОСТІ

Виявлення наземних орієнтирів відповідними пристроями мобільного автономного робота (радаром, ультразвуковим далекоміром, відеокамерами) супроводжується низкою проблем, які потрібно вирішувати.

Орієнтиром будемо називати будь-який зосереджений об’єкт природного або штучного походження, який може бути надійно виявлений роботом на місцевості і від якого буде здійснюватися відлік координат.

Наземний орієнтир, як правило, повинен мати невеликі розміри в горизонтальній площині. Він у більшості випадків є нерухомим і повинен виявлятись на фоні нерухомих об’єктів навколишньої місцевості. Для відеокамер цей факт є сприятливим, але для радара та ультразвукового далекоміра, навпаки, значно ускладнює процес виявлення. Це обумовлено тим, що сигнали, що відбиті від орієнтира та навколишньої місцевості, майже не відрізняються між собою.

В роботі «Determination of landmarks by mobile robot’s vision system based on detecting abrupt changes of echo signals parameters», що була представлена на 44^{th} Annual Conference of the IEEE Industrial Electronics Society в Окрузі Колумбія в жовтні 2018 року професором Полярусом О.В., доцентом